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Research notes: Glyceride structure variation in soybean varieties

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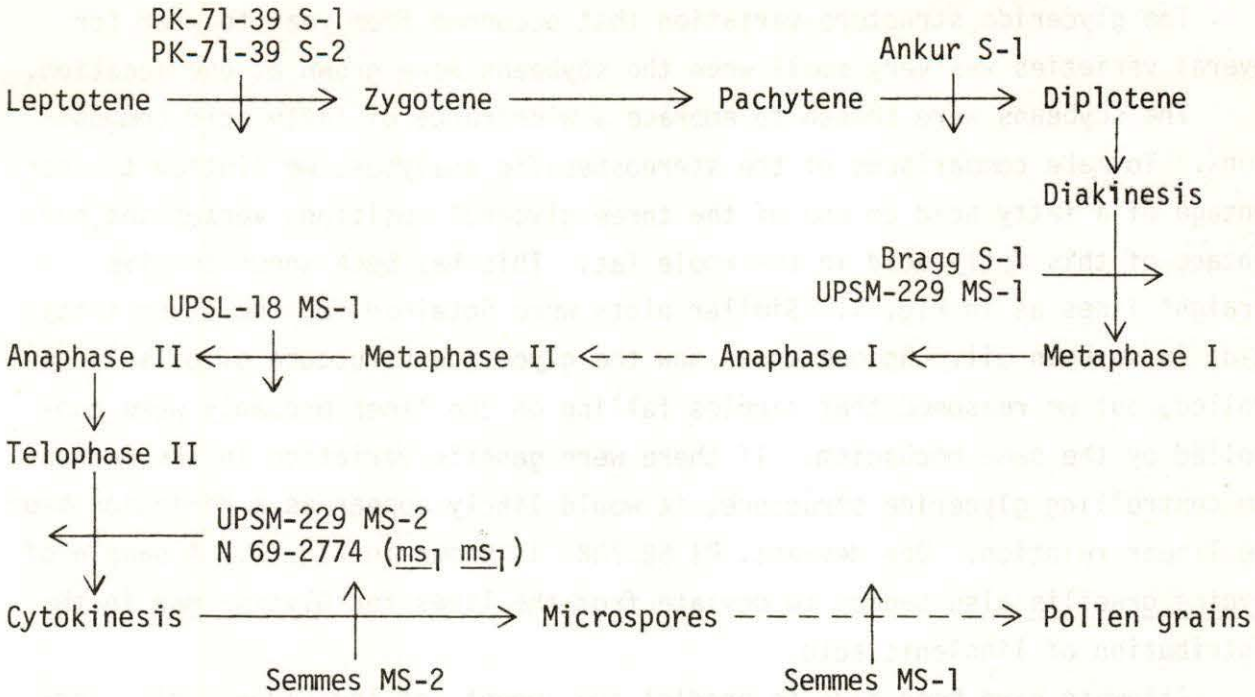

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1) Glyceride structure variation in soybean varieties.

The glyceride structure of an oil, i.e., the combinations of fatty acids that occur together in the triglycerides, may influence its stability to oxidation (Raghuveer and Hammond, 1967). Recently we examined the glyceride structure of about 20 varieties of soybean and related species by two techniques: stereospecific analysis and silver ion chromatography (Fatemi and Hammond, 1977a, 1977b). Stereospecific analysis measures the proportion of each fatty acid on each of the three positions of glycerol. The second technique, silver ion chromatography, partly resolves the triglycerides of an oil according to the number of double bonds per molecule.

The glyceride structure variation that occurred from year to year for several varieties was very small when the soybeans were grown at one location.

The soybeans were chosen to embrace a wide range of fatty acid compositions. To make comparisons of the stereospecific analyses, we plotted the percentage of a fatty acid on one of the three glycerol positions versus the percentage of this fatty acid in the whole fat. This has been shown to give straight lines as in Fig. 1. Similar plots were obtained for the other fatty acids in soybean oil. No one knows how the glyceride structure of oils is controlled, but we reasoned that samples falling on the lines probably were controlled by the same mechanism. If there were genetic variation in the mechanism controlling glyceride structure, it would likely appear as a deviation from the linear relation. One deviant, PI 68.788, is shown in Fig. 1. A sample of Glycine gracilis also seemed to deviate from the lines for Glycine max in the distribution of linolenic acid.

Attempts have been made to predict the amounts of individual triglycerides assuming that random combinations of fatty acids occur with the single restraint that the proportion of each fatty acid on the three glycerol positions must conform to the stereospecific analysis. The groups of triglycerides resolved by the silver ion technique were compared with values calculated by this theory from the stereospecific analysis. In general the agreement was close, but triglycerides that contained two or more oleic or linoleic acids were in amounts greater than predicted while combinations that contained both oleic and linoleic acids were in slightly lesser amounts than predicted. This may be because during ripening, the fatty acid composition of soybeans changes considerably, and the maxima for oleic and linoleic acids do not coincide in time (Fehr et al., 1971). This would depress combinations of the two acids and favor multiple occurrence of one acid on the same molecule.

Plots of the amounts of the triglyceride groups obtained by silver ion analysis versus the percentage in the whole oil of one of their constituent fatty acids revealed regular but nonlinear relations. PI 68.788 was a frequent deviant in these plots also. No other significant deviations were discovered.

The two procedures that we used are too complex to use in screening soybean varieties for deviant glyceride structures, but it is possible to determine the percentages of fatty acids on the 2-position of glycerol and the mixed 1- and 3-positions rather simply by an enzymatic hydrolysis with pancreatic lipase. We believe this would make a feasible analytic method for a screening test.

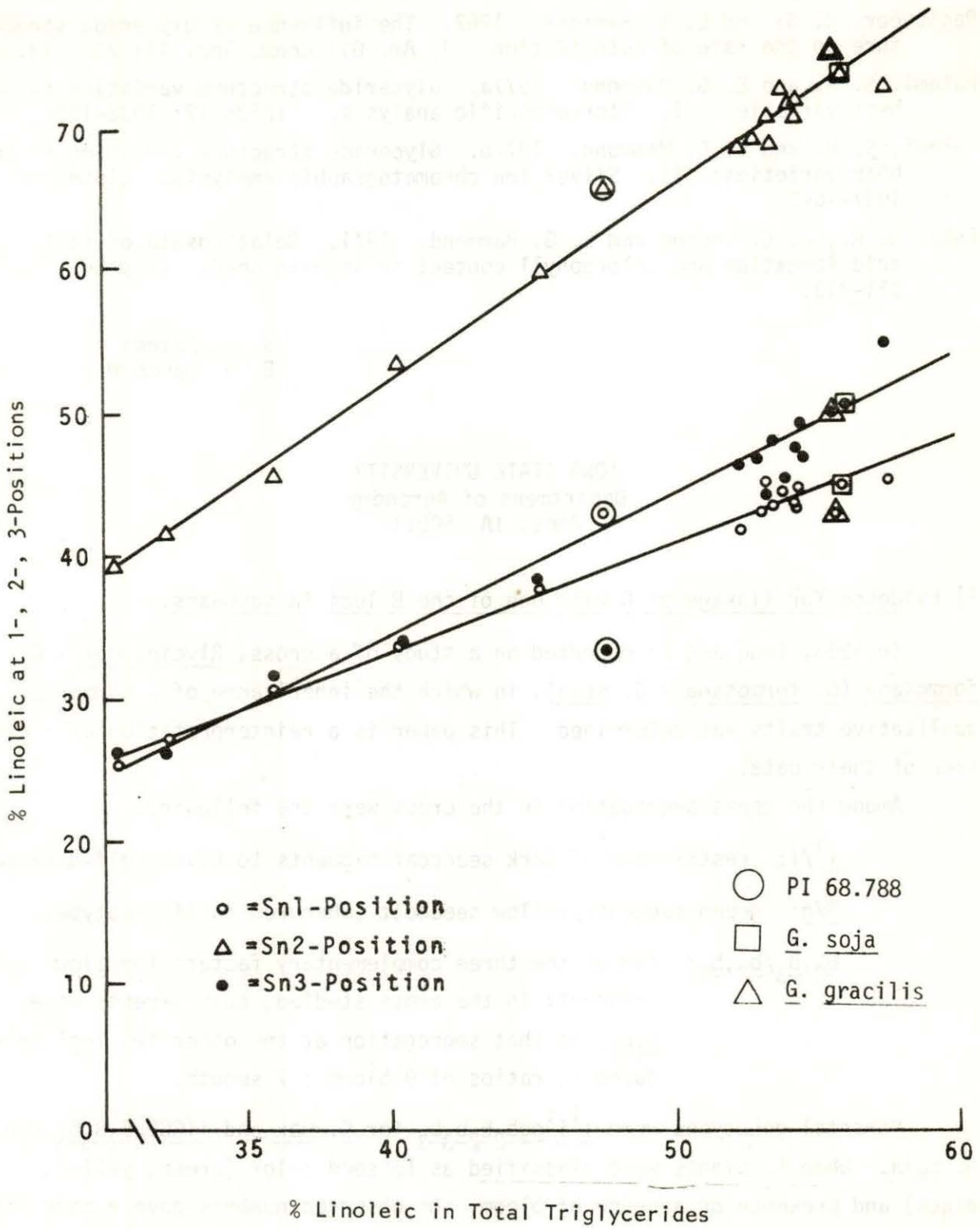

Fig. 1. Distribution of linoleic acid among the 1-, 2-, and 3-positions against changes in the percentage of linoleic acid in the total triglycerides

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1) Evidence for linkage of G with one of the B loci in soybeans.

In 1963, Tang and Li reported on a study of a cross, Glycine max x G. formosana (G. formosana = G. soja), in which the inheritance of a number of qualitative traits was determined. This paper is a reinterpretation of a portion of their data.

Among the genes segregating in the cross were the following:

$\underline{i}^{i}/\underline{i}$: restriction of dark seedcoat pigments to hilum/self-dark seed

G/g: green seedcoat/yellow seedcoat (obscured in ii genotypes)

$B_2, B_3/b_2, b_3$: two of the three complementary factors for bloom on seedcoat; in the cross studied, both parents were B_1B_1, so that segregation at the other two loci produced F_2 ratios of 9 bloom : 7 smooth.

Parental genotypes were $\underline{i}^{i}\underline{i}^{i}ggb_2b_2b_3b_3$ for G. max and $\underline{ii}GGB_2B_2B_3B_3$ for G. soja. When F_2 plants were classified as to seed color (green, yellow, black) and presence or absence of bloom, the observed numbers gave a poor fit (χ^2 probability 0.006) to the ratio expected under independent inheritance. Taken singly, the characters fit the appropriate monogenic and digenic ratios well. Thus, linkage is suspected. The data are consistent with the hypothesis of independent segregation of $\underline{i}^{i}/\underline{i}$ and G/g, and of $\underline{i}^{i}/\underline{i}$ and the genes controlling